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IRON-ABSORPTION BAND ANALYSIS FOR THE DISCRIMINATION OF IRON-RICH ZONES[1]

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Type I Progress Report
ERTS-A

a. Title: Iron-absorption band analysis for the discrimination of iron-rich zones.

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c. Problems relating to progress:

Spring snow fall caused a one-month delay in initial field study, but this work was carried out between April 30 and May 4. During this reporting period, emphasis has been placed on spectral analysis chiefly by digital computer processing techniques. A few technical problems which relate to the processing have arisen; these include scale differences among computer processed images, published maps, and available aerial photographs and degradation of ratio image quality due to atmospheric correction. These problems are under evaluation.

Ground coverage of the test site from ERTS-1 has been scant for the three sequences of passes in February and March due to heavy cloud cover. Hence, very little new data have been available. Repetitive coverage has proven to be extremely useful since seasonal variations such as snow cover and changes in water distribution have brought to notice valuable information.

d. Discussion and plans:

Plans include further work with ratio images and with the color ratio composites. Spectral analysis coordinated with field work will continue, and the computer ratioing technique should progress considerably in the next few months. Several geologic overlays are being brought to the scale of the ratio images. Although only three color ratio composites of the Goldfield, Nevada area have been examined in detail thus far, there is no doubt that they contain a tremendous amount of information, expecially on hydrothermally altered areas.

More field trips are planned in order to gauge the relative importances of rock type and surficial coatings with regard to color discrimination on the ratio images. Laboratory spectral analyses are currently being undertaken on samples collected on a recent field trip to Nevada. Most useful, however, will be data gathered on future field trips with a field spectroradiometer. Although laboratory spectral work is a valuable aid, the importance of spectral measurements of rocks in situ must be emphasized.

In the ratio processing, two spectral bands of a scene are ratioed by computer, resulting in a black and white image which represents the differences between the two original bands. This digital ratioing process is carried out for various combinations among the four bands of an ERTS image. These four bands include a green band (0.5-0.6μ), a red band (0.6-0.7μ), and infrared band (0.7-0.8μ), and a second infrared band (0.8-1.1μ). The ratios prepared for this study are, therefore, G/R, G/IR_1, G/IR_2, R/IR_1, R/IR_2, and IR_1/IR_2*

The next stage involves producing a color ratio composite from three of the black and white ratio images. Each of the three ratio images is given a blue, green, or red filter, respectively. The three images plus their filters are then superimposed, registered, and photographed, which results in a color ratio composite.

Three color ratio composites of the Goldfield area have been produced at this stage. The first one is composed of the G/R ratio (blue), G/IR_2 ratio (green), and the IR_1/IR_2 ratio (red). The resulting image is dominated by various tones of blue and red-brown. The second color composite, made with the G/R ratio (blue), G/IR_1 ratio (green), and the IR_1/IR_2 ratio (red), is very similar to the first composite, with the exception of an additional yellow tone. The third color ratio composite, which looks very different from the other two composites, uses the G/IR_2 ratio (blue), R/IR_1 ratio (green), and the IR_1/IR_2 ratio (red), and, in addition, is atmospherically corrected. The widest variety of colors, blue, green, pink, orange, red, and dark brown, occurs on this color composite.

e. Results and applications:

Since ground orientation can be difficult when using ERTS images, a light plane was flown at about 3,300 meters on a recent field trip to attain a somewhat intermediate synoptic view of parts of the test site in Nevada. It was, as expected, not synoptic enough to see most of the proposed major lineaments, some of which extend for 500 kilometers. Nevertheless, part of the Midas Trench lineament northeast of Pyramid Lake could be discerned, as could the typical Basin and Range faults bounding many of the ranges.

Discrimination of rock type seen from about 3,300 meters correlates well with that seen on the bulk MSS ERTS images. In the Shawave Mountains, western Pershing County, the granodiorite appears light tan on the ground, with a distinctive rough-looking texture. On the ERTS image [E-1002-18125], the area is distinctively lighter than its surroundings, although the texture is not apparent. The Truckee Range, composed primarily of Tertiary basalts and andesites, appears very dark both on the ground and on the image. The granite mountain west of Tonopah and the Oddie rhyolite of its northeast extension can also be distinguished from the air and on the ground. The granite is light and the rhyolite is bright red, due to a limonitic coating; on the image the granite is light and the rhyolite is dark.

* An intermediate grey color on the ratio image indicates an area for which little difference exists between the spectral bands. Large spectral differences are represented by light and dark greys and, in the extreme cases, white and black.

The Goldfield area in south-central Nevada is of special interest because of the extensive Tertiary alteration and mineralization. This is the first area of which ratio images have been prepared.

A comparison of the three color ratio composites with the geology of the area indicates that the light blue area [red-orange on the atmospherically corrected ratio composite (ACRC)] east of the town of Goldfield represents, in general, the Tertiary Milltown andesite. An anomalous red-brown (blue on ACRC) area occurs in the northwest part of the blue area. On the traditional color composite, the area which is blue on the color ratio composite has a slight yellow tinge. This yellow tinge also occurs elsewhere on the image, however, in areas of little economic importance. On the ground, the andesite surface is tremendously varied, ranging from a relatively unaltered dark grey specimen to a very altered black, red, brown, and/or yellow specimen. Thus, the problem of rock discrimination is indeed complex.

The central red-brown (blue on ACRC) oval within the blue area on the color ratio composite represents, in general, a Tertiary latite. On the ground, the latite has a light blue to light purple surface. Slightly southwest is a darker blue area (dark red-brown on ACRC) denoting a Tertiary dacite. On the traditional color composite, it is very difficult to discern the dacite from the latite. Basalts, which are a very dark grey on the ground, appear on the color ratio composite as a very dark red-brown (green and pink on ACRC).

Color discrepancies within these general units indicate that rock type alone is not the sole determining factor of how the rocks appear on ERTS imagery. Limonitic surficial coatings and alteration are playing an important part, but exactly how large a part and under what circumstances remains to be determined. Since mineralization is often so closely related to alteration, it is important to gain as full an understanding as possible concerning altered areas like Goldfield and especially with regard to synoptic views of them.